



**SPS 2014**  
*Sustainable Phosphorus Summit*

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# Towards closed-loop phosphorus management for the UK Water Industry

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# The Project

## Towards closed-loop phosphorus management for the UK Water Industry

**EPSRC\* Case PhD Studentship**

**2/3 funded by EPSRC**

**1/3 funded by industry**

**UK Water Industry Research**

**12 UK Water & Sewerage Companies on Steering Committee**

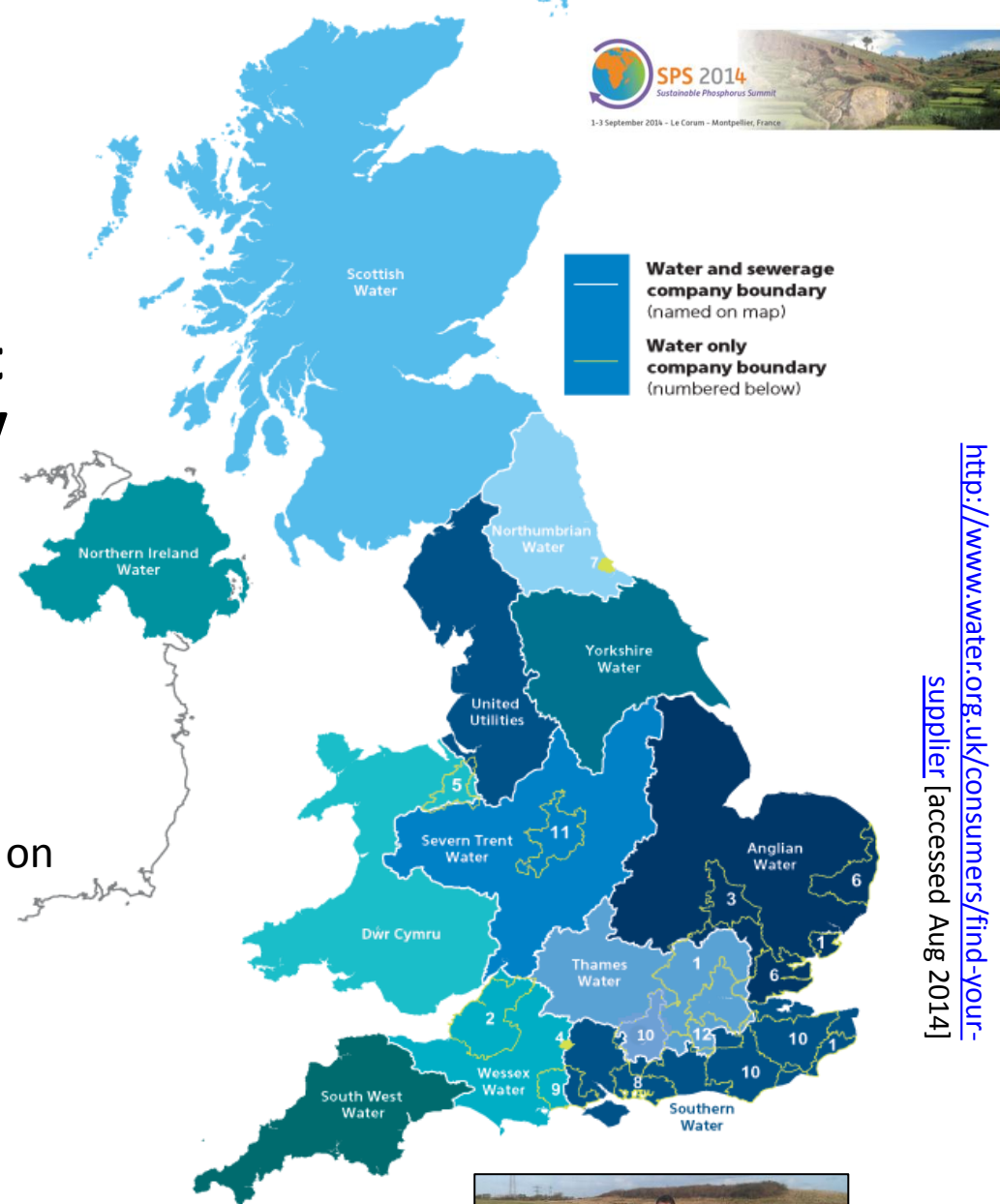
**Started October 2010**

**Ending September 2014**

**Doctoral researcher: James Cooper**

**Principal investigator: Cynthia Carliell-Marquet**

*\* Engineering and Physical Sciences Research Council (UK)*



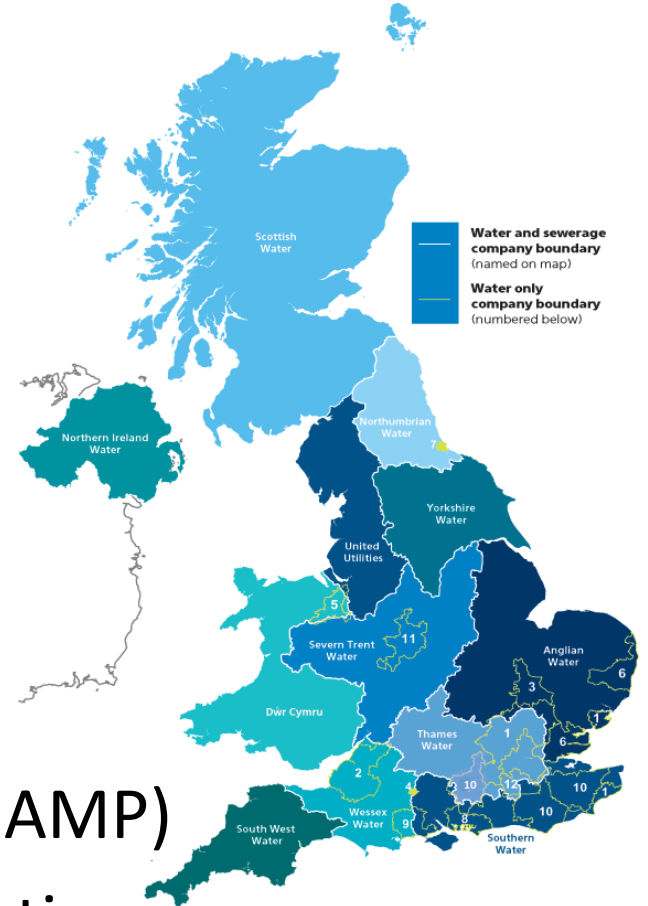
<http://www.water.org.uk/consumers/find-your-supplier> [accessed Aug 2014]





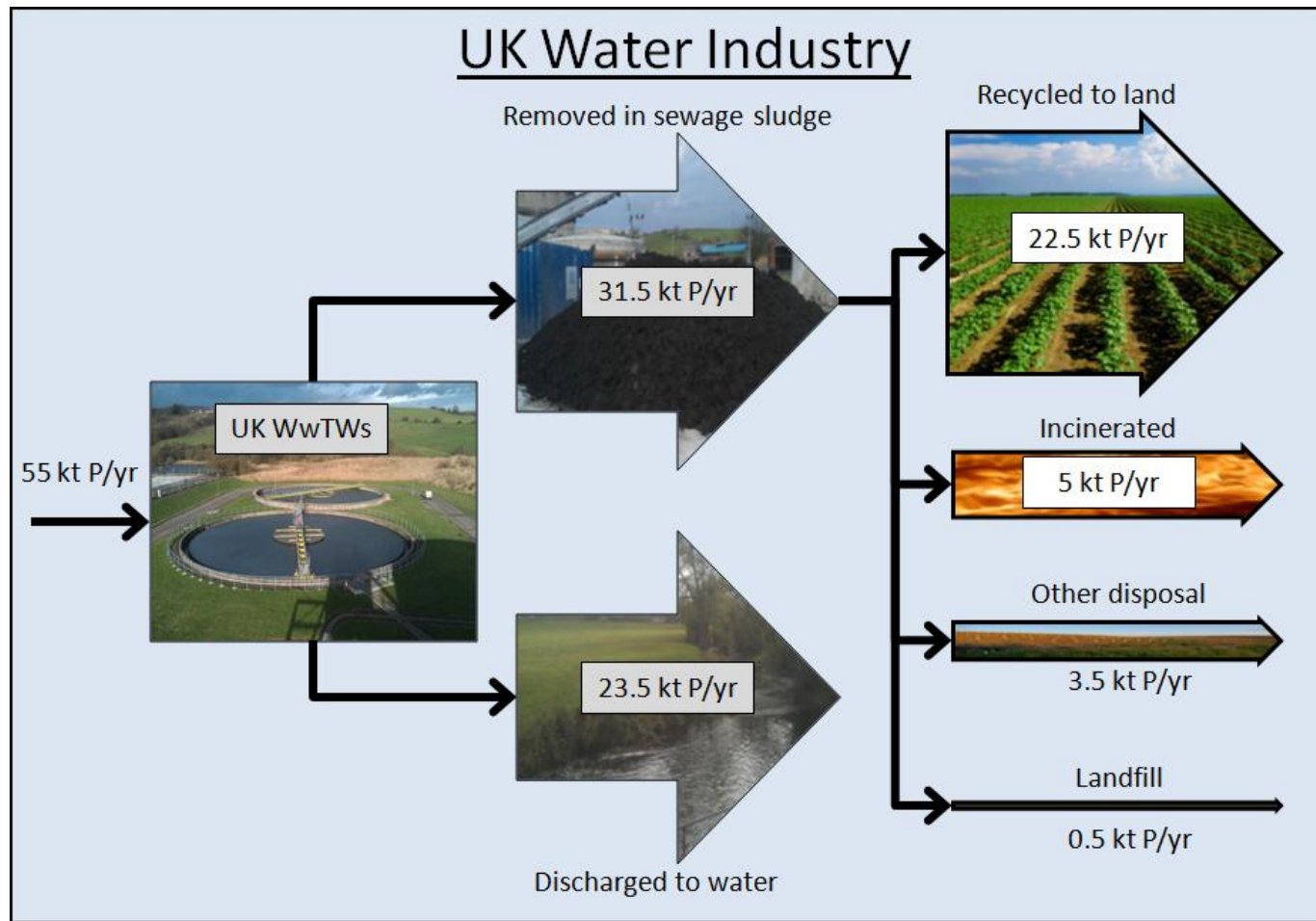
# UK Water Industry - background

- UK Water Industry was privatised in 1989
- 12 Water & Sewerage Companies
- UK population 63.7 million people
  - 15% projected ↑ by 2037
- 96% connected to WwTW
- 11 billion litres wastewater
- 9,278 WwTWs
- Average cost to customers £1/day
- Price regulated for 5-year periods (AMP)
- Currently in 5<sup>th</sup> cycle since privatisation
- 25-year strategic direction statements (from 2010)



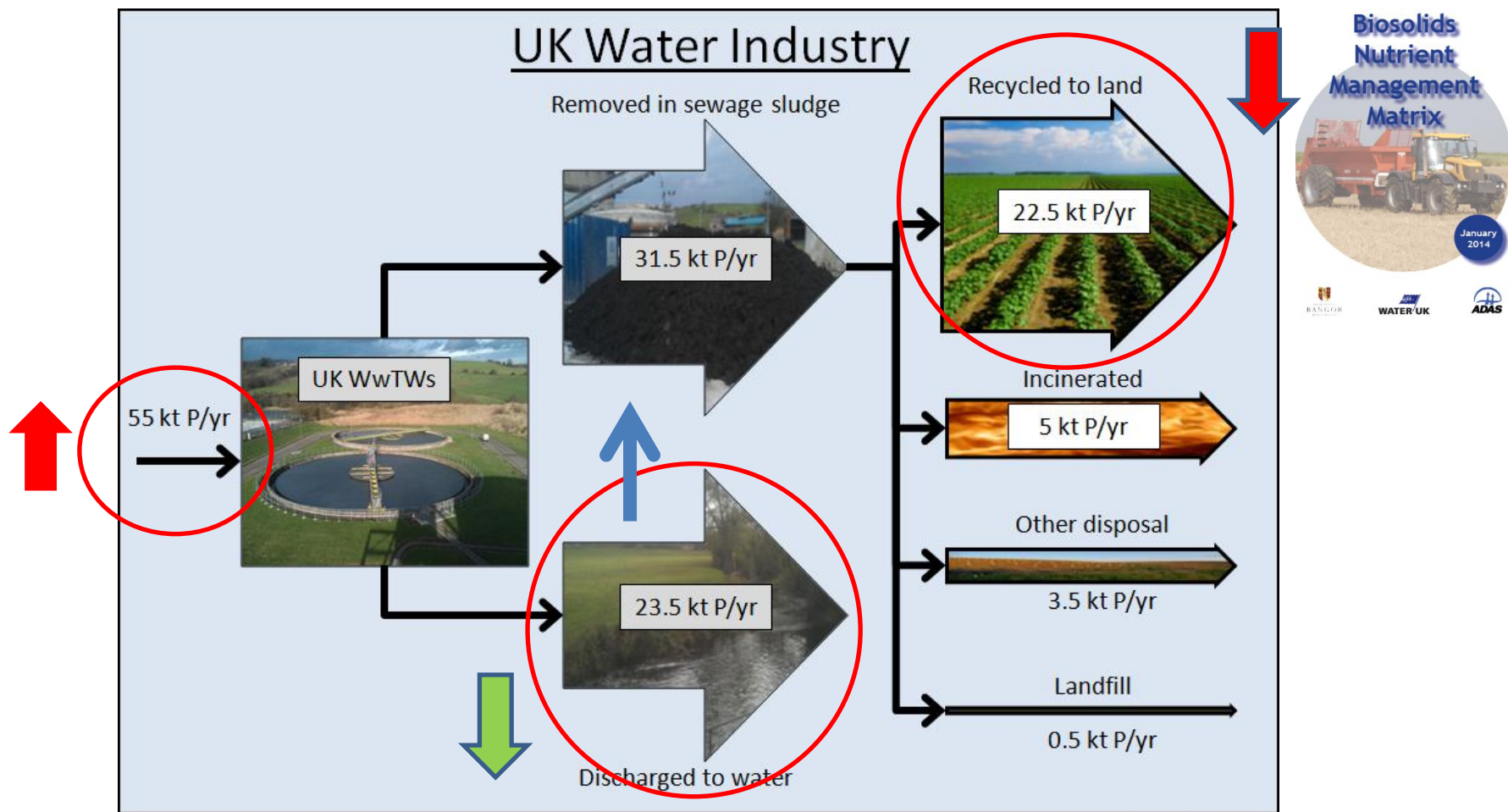
<http://www.water.org.uk/consumers/find-your-supplier> [accessed Aug 2014]

# How much phosphorus in the UK's wastewater?



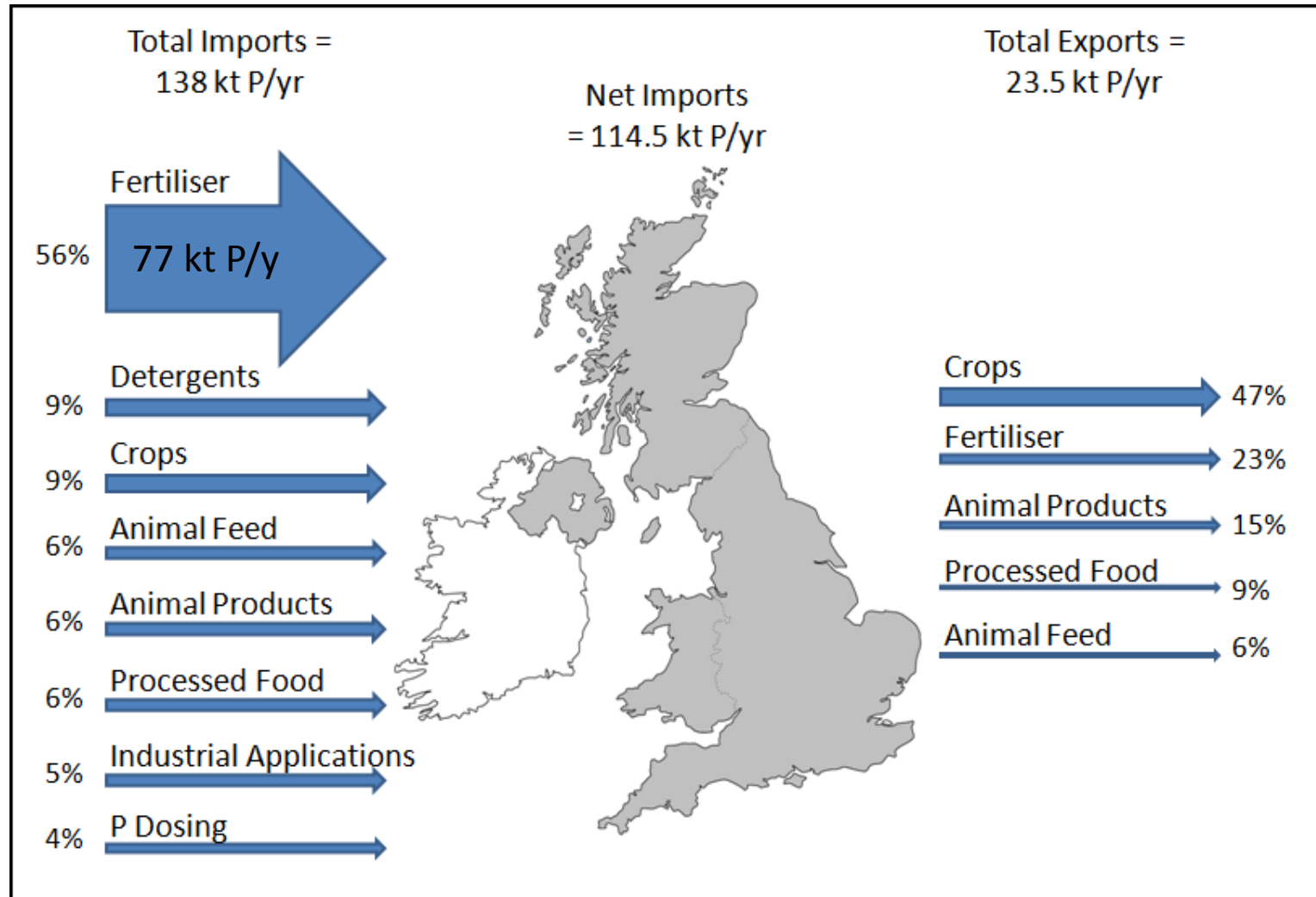
**Cooper, J and Carliell-Marquet, C (2013)** A substance flow analysis of phosphorus in the UK food production and consumption system. *Resources Conservation and Recycling* (74) 82-100.

# How is this likely to change in the future?



**Cooper, J and Carliell-Marquet, C (2013)** A substance flow analysis of phosphorus in the UK food production and consumption system. *Resources Conservation and Recycling* (74) 82-100.

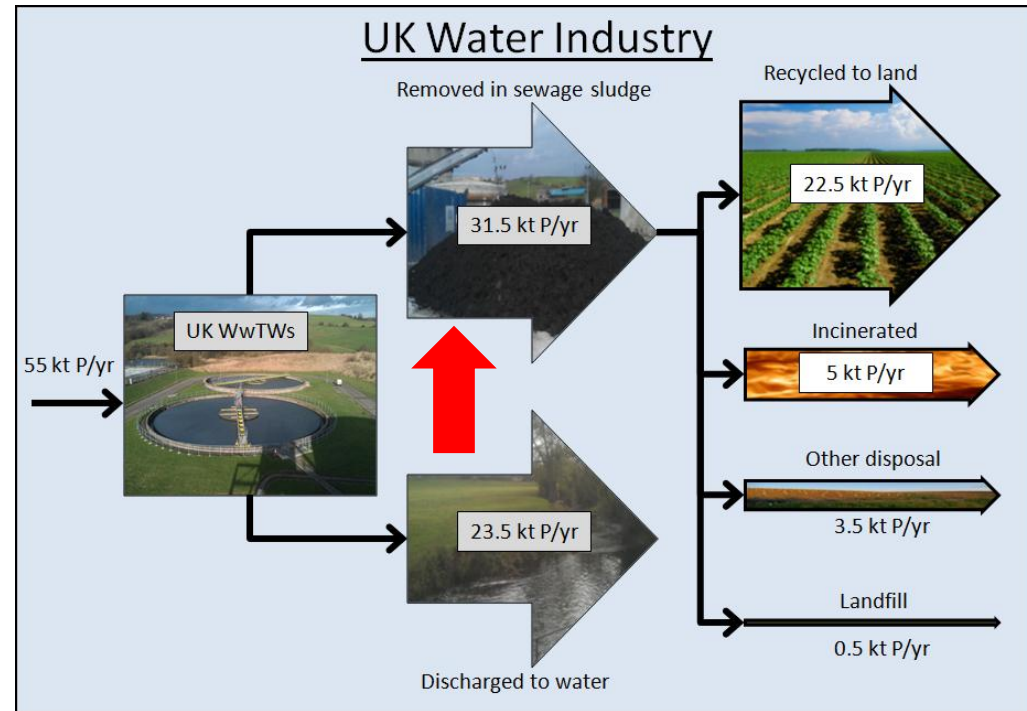
# How does P in wastewater compare to imported P?



Cooper, J and Carliell-Marquet, C (2013) A substance flow analysis of phosphorus in the UK food production and consumption system. Resources Conservation and Recycling (74) 82-100.

# Current picture of the Water Industry for phosphorus **removal**

- P removal shifts P from the **liquid wastewater to the sludge fraction**
  - By adding metals salts to precipitate P (**CPR**)
  - By encouraging bacterial cells to store more P (**EBPR**)



- P removal is employed to **reduce P pollution** and meet environmental discharge standards; its not about recovery of P
- BUT, a WwTW with P removal will shift at least 80 – 90% of influent P from liquid to sludge; concentrating it so it can be **recovered & recycled**
- **EBPR** facilitates P recovery in mineral form, CPR makes this challenging!

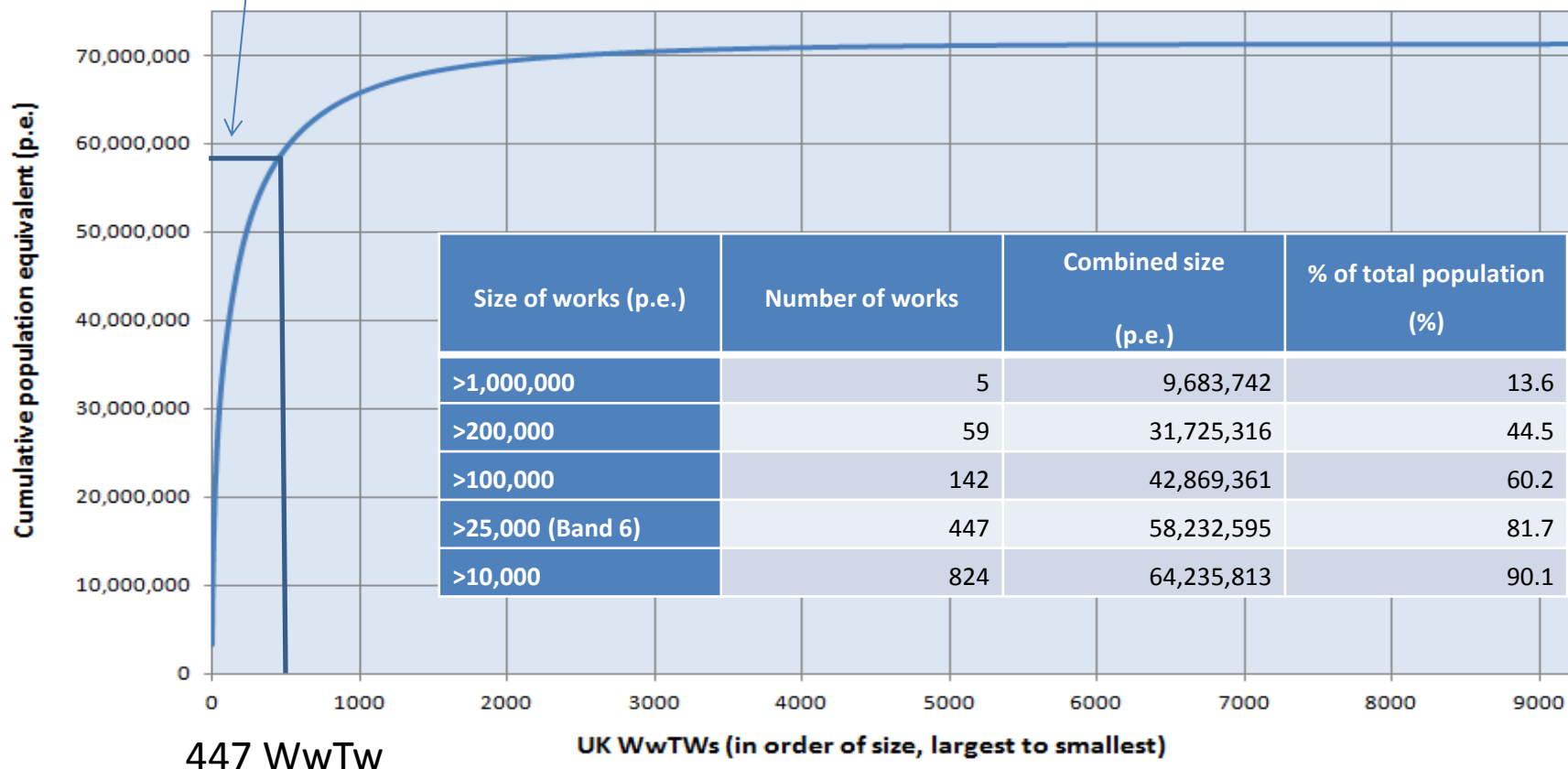


# Structure of UK Wastewater

9,278 WwTW in the UK Water Industry, with a combined **population equivalent** of **71.3 million** people. WwTW range from a few 100 p.e to more than 1 million pe

80% of the p.e. (and P)

Population Profile - UK WwTWs



Source: Cooper, J (2014) PhD Thesis (in preparation)

# P removal - number and population of WwTW

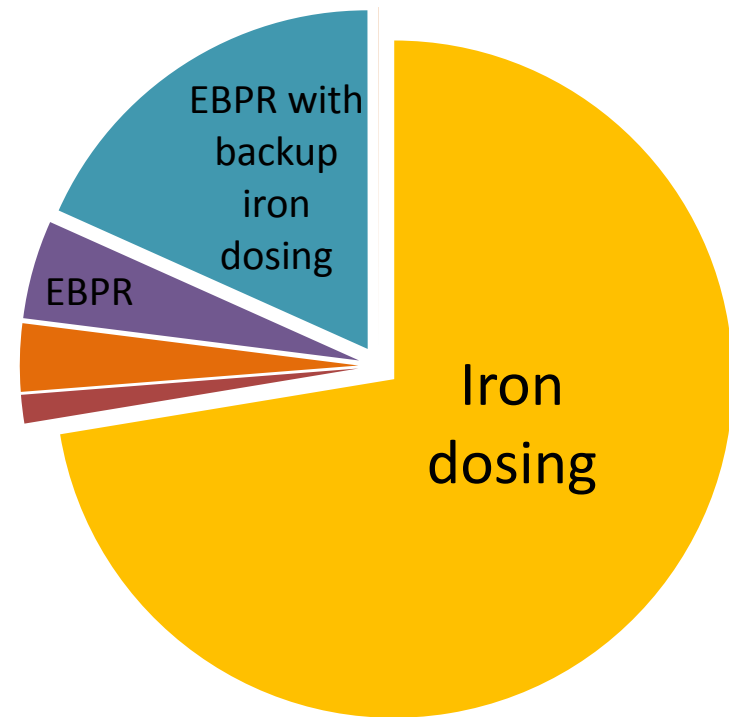
- UWWTD, Habitats Directive, WFD all impose discharge consents for P on sewage effluents
- Currently **476** WwTW with P consents, serving **20.9 million** p.e. (~ 30%)
- By 2015 expected ↑ to **639** WwTW, serving 23 million p.e. (~32%)
- EA (2012) suggested an additional **2,000 WwTW** may require P removal to meet WFD river quality objectives



# How is P removed from wastewater in the UK?

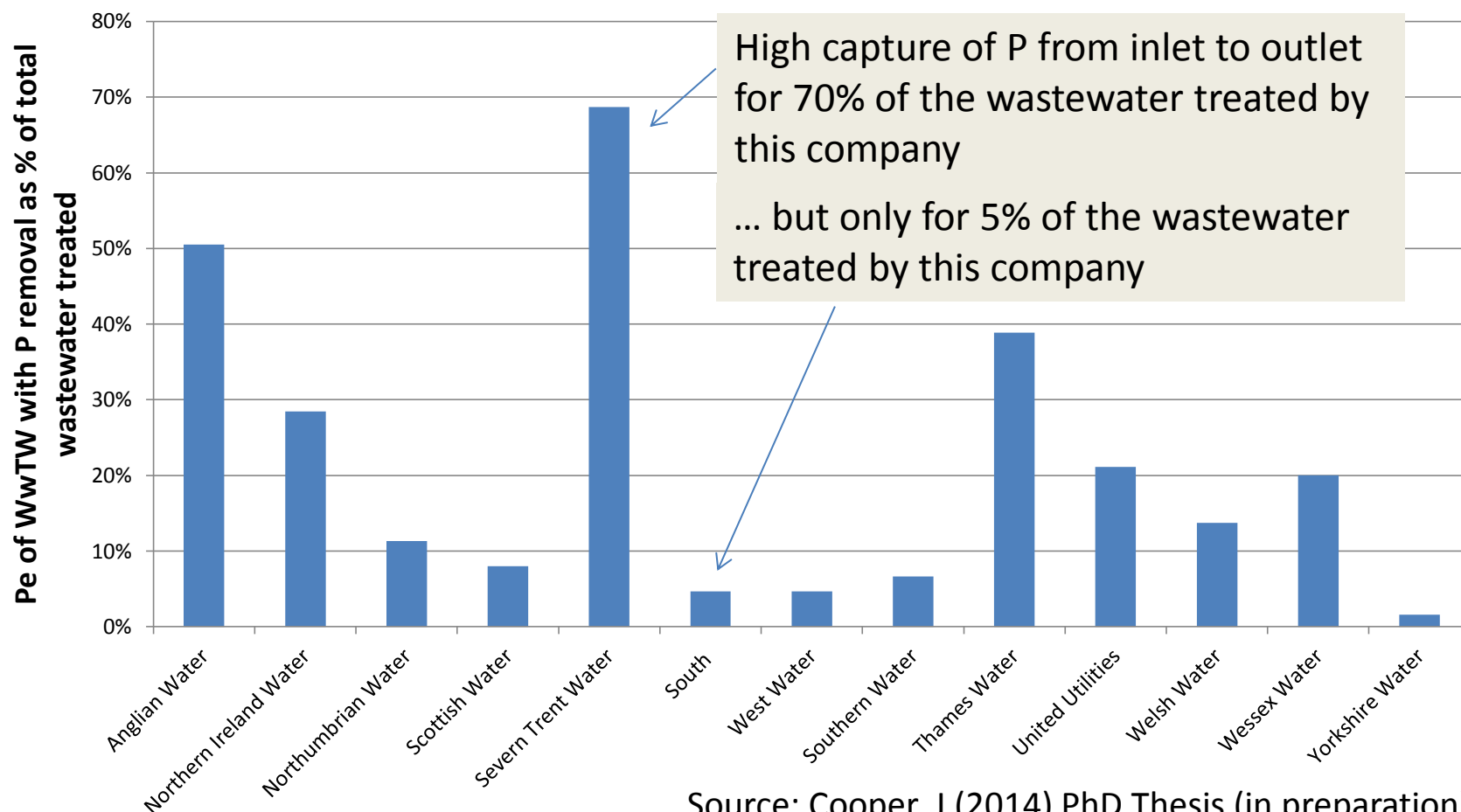
- 95% of WwTW use chemical P removal (CPR)
- In terms of p.e. 77% use chemical dosing and 23% enhanced biological P removal (EBPR)

**Method of P removal  
by p.e.**



# P removal: the UK picture for different water companies

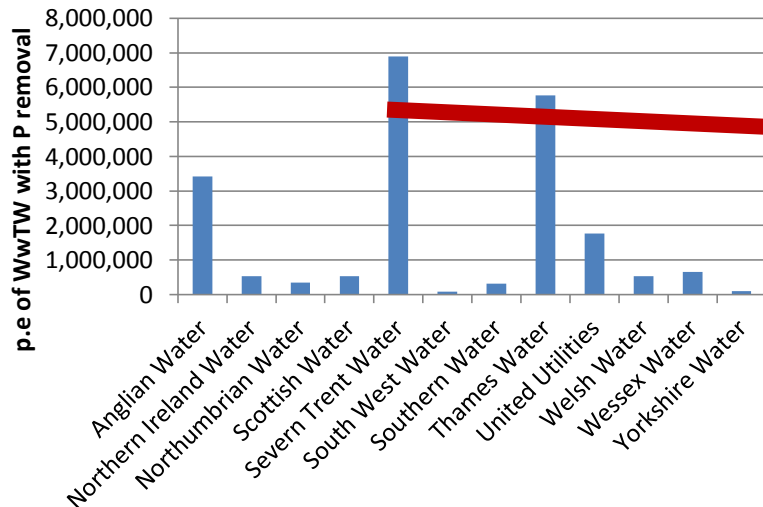
What % of a company's wastewater treatment has P removal?




Source: Cooper, J (2014) PhD Thesis (in preparation)







# P removal: contributions from different water companies



Source: Cooper, J (2014) PhD Thesis (in preparation)



# How ready is the UK Water Industry for P recycling?

- 
- **Readiness for P recycling in a Water Company depends on:**
    - how much P they are capturing from inlet to outlet
    - What form this is in (EBPR, CPR)
    - How much of their sludge can be recycled usefully to agricultural land (sludge cake, compost)
    - How much sludge is incinerated and is P recovered from the ashes
    - Is P recovered from other sources, e.g. biochar
- 
- 
- 

# P recovery – would P trading work?



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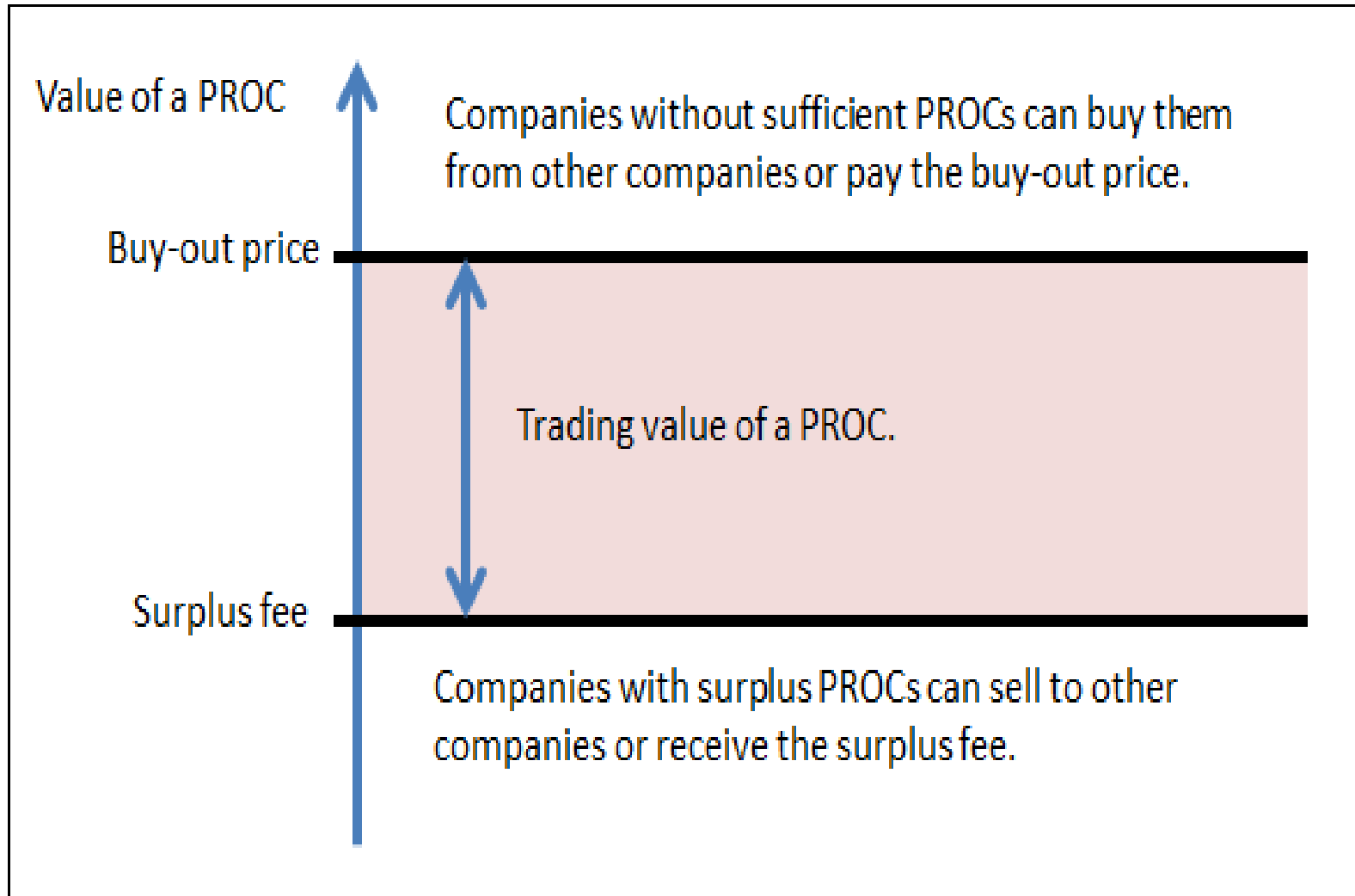
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- Proposing the **Phosphorus Renewable Obligation (PRO)** trading scheme
- **How might it work?**
  - Water Industry will have a P recycling target for a given year
  - These would run in 5 year blocks together with the AMP cycle
  - Working up to 80% P recycling by 2050 (linear pathway in the absence of models to suggest otherwise!)
  - Every kg of P recycled = 1 P Recycling Obligation Certificate (PROC)
  - PROCs allocated to companies based on their P load & the industry recycling target for that year (e.g. 50% target means all WC must recycle 50% of their influent P)
  - Companies that do not meet their obligation must buy PROCs from companies with surplus or pay a fixed 'buy out' fee
  - Companies that produce excess PROCs can trade these to other companies or receive a surplus fee at the end of the year



# Trading P through PROCs



Source: Cooper, J (2014) PhD Thesis (in preparation)





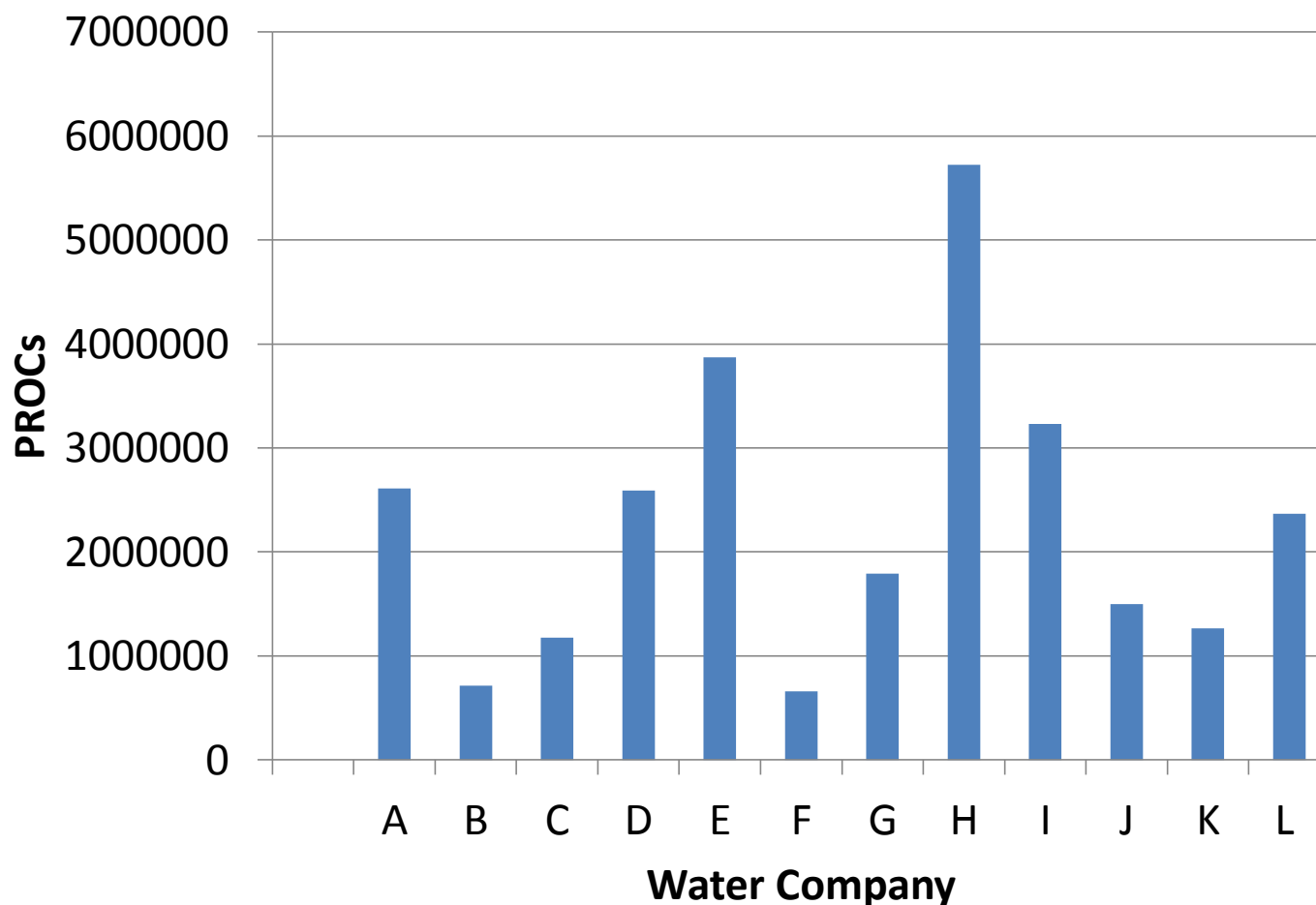
# Banding of PROCs

- Simplest is to have every kg of P recycled = 1 PROC
- But to incentivise certain technologies (e.g. recovery from incineration ash), these could achieve  $> 1$  PROC / kg P recycled
- Or surplus fees could be adjusted based on the type of recycling undertaken, e.g. struvite gains more than sludge to land
- Or each recycling activity could have an associated % of P recycled from that activity, e.g. sludge to forestry counts as 50% recycling whereas sludge to food production counts as 100% recycling

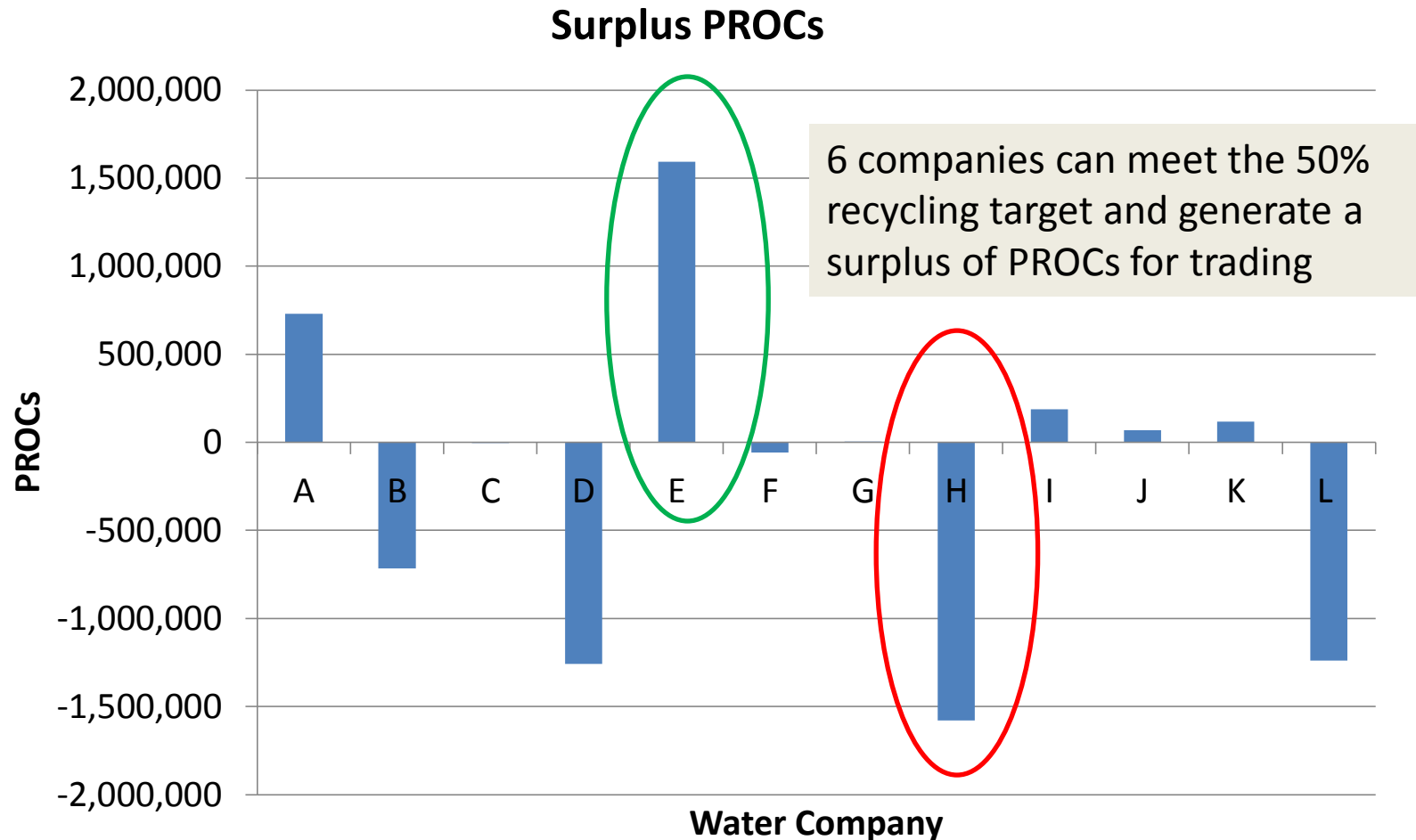


# Current picture of P recycling in the UK

## Water Industry: PROCs allocated to meet an industry-wide 50% recycling target



# PROC surplus & deficits across the water industry: 50% P recycling target with business as usual



Source: Cooper, J (2014) PhD Thesis (in preparation)

6 companies cannot meet the 50% recycling target and must buy PROCs or pay the buy-out fee

# Where to with phosphorus recycling targets?

- How to maximise synergies with environmental legislation requiring P removal
- Does it make sense for companies that do not need to remove P for environmental reasons, to have P recovery targets?
- Should all companies have the same % recycling target?
- How to link up with legislation requiring energy / carbon reductions; how to balance energy requirements of P recovery with carbon reduction commitments?
- Banding of sludge recycling activities; is sludge to land really 'recycled'? Incentivising new technologies ....
- Applying for KTS funding to try out some of these ideas with Severn Trent Water's Strategy Team

